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(54) An emergency watching system using an infrared image processing.

(57) Temperature data of each picture element output from an infrared camera (1) looking at a scene to be watched is compared with the same data of the previous frame. Temperature data changed from the previous frame is input to a histogram operator (10) having a region defined by temperature and quantity of the picture element. When a quantity of the picture elements in the defined region exceeds a threshold level, it is recognized that a certain object having considerable temperature change and size is detected to output a signal to trigger an alarm system (9), or to sustain circulating frame memories (3, 4) which have recorded the previous scenes so that the scenes of visible light as well as the temperature patterns, frames prior and on/or after the signal output, can be reproduced as visual images on a display screen. It is preferable to add an offset temperature to the current frame temperature data before the above mentioned comparing operation, so that the circuit becomes simple owing to an always

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positive comparison result.

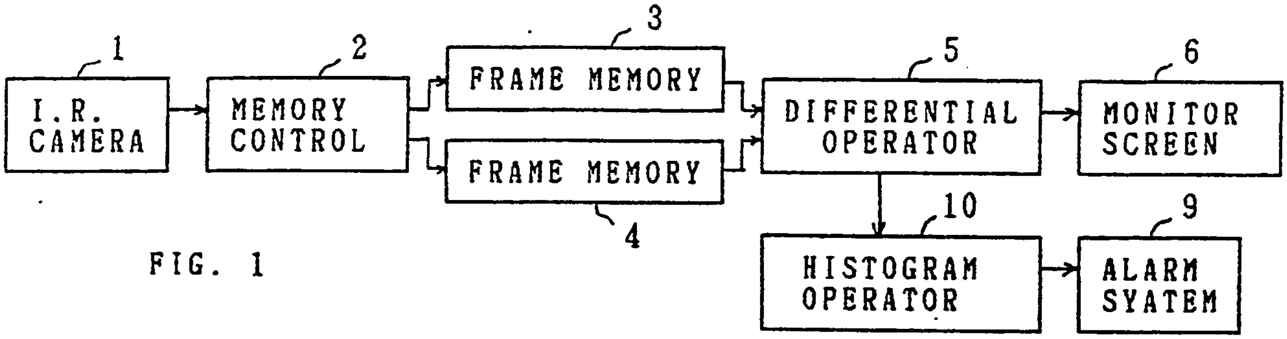


FIG. 1

AN EMERGENCY WATCHING SYSTEM USING AN INFRARED IMAGE PROCESSING

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to an unmanned emergency watching system using an infrared monitoring camera and its image processing, and more particularly to watching an unusual temperature rise of facilities or an invasion of unexpected persons ("burglar").

Description of the Related Art

In a burglar alarm system, there have been generally employed a video camera system or a light beam sensor system in order to detect an invader. In this video camera system, a watchman has to constantly monitor a display screen showing the scene to watch, or an electronic circuit is employed to detects and recognizes a change in the video signals output from the camera. In the light beam sensor system, a beam of invisible light, typically an infrared light, is projected through the area to be watched, and an interruption of the light beam by the invader is electronically detected. In a facilities-trouble finding system, where the trouble is typically represented an abnormal temperature rise of the facilities, a contact-type sensor, typically a thermometer, is attached on some part of the facilities or a non-contact type infrared detector or camera is employed.

In these conventional systems there are problems as described hereinafter: In a system using a visible light camera, it is impossible for a human to pay constant and perfect attention on the display screen; therefore, there has been employed a data processing technique which electronically detects a change in the video information, such as brightness and/or the color, or a change in the temperature (as disclosed in Japanese unexamined patent publication Sho 62-111588) of each picture element of each frame. However, these electronic detection system detects even a little change of the object scene, such as small vibration of a tree or an invasion of a small animal or a flying leave, which are not intended to detect. Thus, the dependability of the system is lowered.

In order to lower this excessive sensitivity of the system, there is proposed a system that an alarm signal is output only when a sum of temperature-changed picture elements which have changed from the previous frame more than a predetermined first threshold quantity exceeds a second threshold quantity, as disclosed in Japanese unexamined patent publication Sho 57-160282 for the case using a video camera of visible light. In a system using a contact-type thermometer, the thermometer must be installed on a dangerous part of the facilities, such as a high voltage machine. Accordingly, the installation of the contact-type thermometer is sometimes impossible. An infrared thermometer can be used in place of the contact-type thermometer as a remote sensor. However, when an infrared thermometer or the contact-type thermometer is used for detecting a temperature rise of the facilities, the monitoring is limited to only a part of the facilities, accordingly, it is not suitable to monitor a wide area of the object.

On the other hand, in a conventional system, a signal generated by detecting a significant change in the object scene is used to actuate an alarm system, to trigger a memory device to later actuate output the stored information or to initiate a video tape recorder and so on. However, in these systems there is a problem in that once the trigger signal is output, the scene prior to the trigger signal can not be reproduced.

SUMMARY OF THE INVENTION

It is a general object of the invention, therefore to provide an emergency watching system to detect an abnormal temperature change in an object scene or invasion of a burglar.

It is another object of the invention to provide an emergency watching system which responds only to an object larger than a predetermined size of a predetermined temperature range.

It is still another object of the invention to provide an emergency watching system to reproduce a scene taken prior to as well as after a detection of an abnormal temperature change in an object scene.

According to the present invention, temperature data of each picture element output from an infrared camera is alternately stored in a pair of frame memories for each frame while previous data stored therein is renewed. Newly input data is compared with the data of the previous frame stored in the opposite frame memory, so as to obtain the temperature change. The picture elements belonging to each temperature segment are grouped as a histogram. A grand total of quantity of the picture elements in a predetermined tem-

perature range and over a predetermined first threshold quantity in each temperature segment is calculated for each frame. If the grand total is more than a second predetermined threshold quantity, a signal is output to actuate an alarm system. The trigger signal may sustain a circulating memory device which stores data of scene taken prior to and/or after the trigger signal so that the abnormal scene is checked by comparing both the scenes. The quantity/temperature specification for outputting the trigger signal may be selected from software tables depending on the object scene monitored by respective infrared camera.

The above-mentioned features and advantages of the present invention, together with other objects and advantages, which will become apparent, will be more fully described hereinafter, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a block diagram of the first preferred embodiment of the invention of claim 1, 3 and 4.

FIG. 2 shows a block diagram of the second preferred embodiment of the present invention of claim 2.

FIGS. 3 show flow charts for comparing a prior art, the invention of claim 1 and the invention of claim 2.

FIG. 4 shows a histogram employed in a histogram operator of the present invention.

FIG. 5 explains the operations of the invention of claim 2 in comparison with the invention of claim 1.

FIG. 6 shows a block diagram of the third preferred embodiment of the present invention.

FIG. 7 shows details of the circuits of FIG. 6.

FIG. 8 shows a block diagram of the fourth preferred embodiment of the present invention.

FIG. 9 schematically illustrates the operation of a circulating memory employed in the fourth preferred embodiment of the present invention.

FIG. 10 shows a comparator employed in a abnormality detection circuit of FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to a block diagram in FIG. 1 and a flow chart in FIG. 3(b), a preferred embodiment of the present invention is hereinafter described. FIG. 3(a) shows a flow chart of a prior art for comparison. An infrared camera 1, having picture elements of, for example approximately 8000 elements, and approximately 1.5 frames per second, looks at an object scene to be watched. The camera 1 sequentially outputs brightness signal, i.e. temperature data of each picture element. A memory control circuit 2 receiving the temperature data from the camera 1 delivers to one of frame memories 3 and 4, alternately by each frame, as denoted with the step (5). Each of the frame memories 3 and 4 is, for example, of 48 K bit adequate to store the one frame data of the camera 1. Addresses of each picture cell are designed same for each frame memory 3 and 4. When new data is stored in the frame memory 3 or 4, previously stored data therein is replaced by the newly stored data. A differential operator 5 compares the newly (or currently) stored data in each picture element of one 3 (or 4) of the frame memories with the previous frame's data stored in the same address of the opposite or other frame memory 4 (or 3), as shown in the step (6), and outputs the comparison difference to a monitor screen 6. Accordingly, the monitor screen 6 displays only the portions where the current temperature has changed from the previous frame, and the brightness of the displayed portion indicate the temperature difference.

The temperature difference signal output from the differential operator 5 is also input to a histogram operator 10, as shown in the step (7). The histogram operator circuit 10 is composed of a digital data processing circuit in which the quantity of picture elements belonging to predetermined temperature segments, such as 30.0 to 30.9 °C, 31.0 to 31.9 °C and so on, are respectively grouped and counted so as to make a histogram as shown in FIG. 4. After counting in the histogram is finished for each frame, if a total quantity of picture elements in a hatched area of FIG. 4 exceeds a predetermined second threshold quantity level Q_D - (not shown in the figure), it is recognized that the temperature change in the object scene is of an abnormal state, accordingly the histogram operator 10 outputs a trigger signal as shown in the step (8). The above-mentioned hatched area is defined that the temperature is higher than a predetermined first threshold temperature T_L, for example, 31.0 °C, and lower than a predetermined second threshold temperature T_H, for example, 39.0 °C, as well as the number of the picture elements grouped in each temperature segment is higher than a predetermined first threshold quantity level P_D. The second threshold temperature T_H may be sometimes omitted according to the requirement. This quantity/ temperature histogram specification, including T_L, T_H, P_D and Q_D, is installed in a firmware in the histogram operator 10 or may be

selected from preprogrammed software tables. Due to the histogram operation, a small object, such as a small animal, or an object having only a little temperature change does not allow outputting the trigger signal. The trigger signal is used for actuating an alarm system 9, a video tape recorder or other circuit as described later on. In the above-described steps of the operations, the steps (5), (6), and (9) are essentially the same as the steps (1), (2) and (4) of the prior art shown in FIG. 3(a).

The histogram operation itself has been employed in combination with a visible light camera as mentioned in the related arts. However, the monitoring of temperature change, which is the very representative indication of an abnormality, i.e. an emergency, by means of the histogram operation according to the present invention without being disturbed by a slight change of an object in the visual scene having little or no temperature change, better effectively achieves the purpose of the emergency watching. Thus, the dependability of the watching system is greatly improved. Another advantage of the histogram operation of the temperature change is that the histogram conditions can be arbitrarily designed to meet a different purpose, i.e. the type of the object to watch.

A second preferred embodiment of the present invention is hereinafter described referring to a block diagram in FIG. 2, and a flow chart in FIG. 3-(c). The infrared camera 1, the memory control circuit 2, the frame memories 3 and 4 are essentially the same as those of FIG. 1. An detrailed explanation is further made in FIGs. 5. In FIGs. 5, at a time t_1 no abnormal temperature change is generated yet, accordingly the temperature of the object scene, is now 10 °C. In the next new frame at a time t_2, an abnormal object having a temperature of 30 °C is detected. An offset temperature 20 °C is respectively added to both of the temperatures of the background scene and the abnormally temperature-changed object, accordingly they become 30 °C and 50 °C, respectively. The offset temperature 20 °C is added in an offset adder 11 to the last temperature data, which is currently input to the frame memory 3 (or 4), for each picture element, as shown in the step (11) in FIG. 3(c). An output of the offset adder circuit 11, i.e. the sum of the offset temperature 20 °C and the new temperature data, is input to the differential operator circuit 5′,and is compared therein with the output from the frame memory 4 (or 3) storing the temperature data of the previous frame, i.e. of time t_1, as the step (12) of FIG. 3(c) for each picture element. That is to say, the background temperature 10 °C of the previous frame is reduced from each of the offset-added temperatures of the background scene, 30 °C, and of the offset-added abnormally temperature-changed object, 50 °C, respectively. Accordingly, the resultant temperatures become 20 °C and 40 °C, respectively. The temperature difference data of each picture element output from the differential operator circuit 5′ is binarized in a binarization circuit 12 by the background temperature 20 °C, as described hereinafter. The binarization is that the binarization circuit 12 outputs a "0" level for the picture element having the offset temperature 20 °C, as well as outputs a level "1" for the picture element having any other temperature than the offset temperature 20 °C. The output "1" from the binarization circuit 12 enables an extractor circuit 13, which extracts data from a picture element in the the frame memory 3 (or 4) into which data from the camera is currently input. The data extracted by the extractor circuit 12 is input to the histogram operator circuit 10, where the first threshold temperature T_L has been set at 30 °C as shown in the histogram of FIG. 5(a). The histogram operation is essentially the same as that of the first preferred embodiment of FIG. 1. Accordingly, essentially same procedure is carried out in the histogram 10 as the step (15). The steps (10), (16) and (17) are also essentially the same as the steps (5), (8) and (9) of FIG. 3(b). The trigger signal, the output of the histogram operator 10, actuates an alarm system 9 in the same way as that of the first preferred embodiment shown in FIG. 1.

Advantage of employing the offset addition is as follows: For a comparison, the case without the offset operation is explained in FIG. 5(b), where the temperature of the abnormal object is 30 °C, which is lower than the background temperature 40 °C. The output of the differential operator circuit 5′ becomes -10 °C. However, it is not preferable for the successive process to handle both of the plus and negative values. According to the offset addition, the results of the differential operation always fall on the positive values, even in the case where a burglar having a temperature 30 °C invades into a scene of higher temperature 40 °C. Accordingly, the offset temperature is chosen to be larger than the temperature difference 10 °C of the anticipated background temperature 40 °C which is higher than the anticipated abnormal object temperature 30 °C. Thus, the circuit structure can be simplified. Furthermore, the temperature data of only the picture elements having temperature change are extracted to be input to the histogram operator 10. Thus, according to the introduction of the histogram operation a natural temperature change in the background does not require an adjustment of the first threshold temperature over which the quantity of the picture element is to be counted. The above mentioned natural temperature change means such as the seasonal temperature change in summer from winter or in daytime from night. Though in the

above description the offset temperature is chosen 20 °C, it is apparent that other temperatures than 20 °C can be used depending on the requirement.

A third preferred embodiment of the present invention is hereinafter described referring to FIG. 6. There are provided a plurality (n) of infrared cameras 111-1 through 111-n, each of which is essentially the same as that of the first infrared camera 1 of the first preferred embodiment shown in FIG. 1, however, respectively look at different object scenes. A video switcher 113 selects one of the infrared cameras 111 so as to deliver its output to an abnormality detection circuit 112, which is composed of essentially the same as those memory control circuit 2, frame memory 3 and 4, differential operator 10, of the first preferred embodiments of FIG. 1, except that the histogram operator 10′ used therein operates according to variable threshold conditions, i.e. specifications. That is to say: there are provided a plurality (m) of specification tables 123, each of which stores a different specification for defining the hatched area of FIG. 4, i.e. the first threshold quantity P_D, the first threshold temperature T_L and/or T_H and the second threshold quantity Q_D, for histogram operation in the histogram operator 10′. A switching controller 125 outputs a signal to actuate the video switcher 113 so as to sequentially select one of the infrared cameras 111 and, at the same time, to select a predetermined one, corresponding to the selected camera, of the specification tables 123. Specification data of the selected specification table is input to the histogram operator 10′ via the switching controller 125. The switching controller 125 is composed of widely used data processing circuits. When the histogram operator 10′ recognizes that the signal from a selected camera exceeds the threshold condition input from the corresponding specification table, the histogram operator 10′ outputs a trigger signal to an alarming system 9, which may be essentially the same as that described in the first and second preferred embodiment of FIGs. 1 and 2.

Further detailed circuit constitution of the above-described third preferred embodiment of the present invention is hereinafter described referring to FIG. 7, where same or like reference numerals denote same or corresponding devices. A first infrared camera sensor 211-1 is for monitoring a burglar. A camera controller 213-1 is instructed by a control board 225 via a transmission line 215 to give operating condition, such as monitoring temperature range, temperature segmentation width, etc., to the first infrared camera sensor 211-1. The monitoring temperature range is set, therefore, typically with 0 to 40 °C for the camera monitor 211-1. The camera controller 213-1 also delivers an output signal of the camera sensor 211-1 to the transmission line 215. The camera sensor 211-1 is moved by a stage 214-1, instructed via the transmission line 215 by the control board 225, so as to properly look at its object scene, in this example, a path through which a burglar may invade into the facilities to be protected. The infrared camera sensor 211-1, the camera controller 213-1 and the stage 214-1 compose the camera 111 of FIG. 6. A second infrared camera sensor 211-2 is for monitoring an abnormal temperature rise of facilities, for example, an electric power transformer, accordingly, looks at this transformer, and the temperature range is set typically with 20 to 300 °C by the camera controller 213-2. The transmission line 215 is of a generally used bidirectional multi-channel transmission system, such as optical fiber, telephone line, etc. A video switcher 213 is composed of a plurality of general switches, such as mechanical switches or semiconductor switches. A switch in the video switcher 213 selectively connects an output of a camera sensor 211 via the camera controller 213 and the transmission line 215 to a memory control circuit 2, according to the timing instructed from the switching controller 125. In this embodiment, there are prepared two specification tables 123-1 and 123-2, corresponding to the camera sensor 211-1 and 211-2, respectively. The first table 123-1 stores a condition for the burglar watching specifying, for example, P_D: 2, T_L: 10 °C, T_H: 35 °C and Q_D: 4 to 20, for the first infrared camera sensor 211-1 having approximately 8000 picture elements. The second specification table 123-2 stores a condition for the facilities' trouble watching specifying, for example, P_D: 2, T_L: 80 °C, T_H: 100 °C and Q_D: 4 to 20. Accordingly, during the time period selecting the first camera sensor 211-1 the first specification SPEC.1 is input to the histogram operator 10′ as well as the second specification SPEC.2 for the second camera 211-2. The switched period for selecting one camera sensor and the specification is generally chosen -- m second, during which the histogram operation is fully carried out.

Though, in the description of FIG. 7, only two sets of the cameras and the specification tables are provided, there may be added any number of the cameras and specification tables. For example, in a case of additionally monitoring a power circuit breaker its most suitable histogram operation condition can be stored in an additional specification table. Accordingly, quite different objects, such as a burglar and facilities's trouble, each of which requires different individual condition can be efficiently monitored at the same time using a single set of histogram operator.

Though in the third preferred embodiment, the histogram operator 10′ is essentially the same as those of the first preferred embodiment of FIG. 1,

the data input to the histogram operator 10′ may also be processed with offset addition as well as the binarization operation described in the second preferred embodiment shown in FIG. 2.

A fourth preferred embodiment of the present invention is shown in a block diagram of FIG. 8. A first infrared camera 1, a visible light camera 14 and a second infrared camera 15 look at a same object scene 20 to monitor. The first infrared camera 1 is the same as that of FIG. 1, and is for detecting an abnormal temperature change in the scene. The visible light camera 14 and the second infrared camera 15 are for reproducing the scenes of before and on/after an occurrence of the abnormal temperature change, as explained later in detail. The cameras 14 and 15 are generally synchronized in the frame scanning. An output signal carrying temperature data of each picture element of the first infrared camera 1 is input to an abnormality detection circuit 30. The abnormality detection circuit 30 may be composed of the memory control circuit 2, the frame memories 3 and 4, the differential operator 5 and the histogram operator 10 of FIG. 1. Alternative constitutions of the abnormality detection circuit 30 are described later. A first set 18 of frame memories is composed of a plurality of frame memories, each of which circulatingly stores image data, such as brightness and chromaticity, of each picture element of sequential frames, output from the visible light camera 14. Each of frame memories 18 is typically composed of widely used 64 K bit semiconductor RAM (random access memory). A second set 19 of frame memories is composed of a plurality of frame memories. Each of the frame memories 19 circulatingly stores temperature data of each picture element of each sequential frame, output from the second infrared camera 15. Each of frame memory 19 is typically composed of widely used 64 K bit semiconductor RAM. Number of the frame memories of the first and second set 18 and 19 is for example, five each as shown in FIG. 9. Number of the frame memories of the first and second set 18 and 19 is generally equal. Operation of the above mentioned circulating storage of the image data is such that each of the five frame memories, #1 through #5 as shown in FIG. 9, stores data of the sequential five frames, respectively, where the data stored in #1 frame is renewed by the data of the sixth frame. The same procedure is repeated for the successive frames, the seventh frame data in #2 frame and so on. The circulating storage operation is stopped when the trigger signal is output from the abnormality detection circuit 30. Assuming that the trigger signal is output when the #3 frame memory is renewed with the latest or current frame data as shown in Fig. 9, the scene at which a certain temperature change defined by the histogram conditions takes place can be reproduced by reading out the data stored in #3 frame memory. Furthermore, the scenes before that can be reproduced from the data in the #2, #1, #5 and #4 frame memories in the order of going back to older frames. Accordingly, assuming a case where the abnormality is a fire, the developing process of the fire can be traced back by the records of the past four frames. Thus, the temperature data store in any frame of the second set of frame memories 19 can be reproduced as a visual image on a display screen 20-2. In same manner, the visible light camera's data stored in the first set of the frame memories 18 can be reproduced as a visual image showing the development of the smoke on a display screen 20-1. Though in this description of the embodiment of the present invention the circulating storage of the frame memory is stopped at the end of the frame by which the trigger signal is generated, the circulating storage may be arranged so as to stop after data of some more frames are stored in the circulating memories. Then, the development of the abnormal state can be observed from the frames of even after the trigger signal.

Therefore, it is very advantageous for a watchman to be able to know the history of the successive development of the flame and the smoke, etc., by visual images both prior to and on/after the detection of the abnormal state, including information of the temperature, colors and shapes, so that the watchman can judge the status correctly and determine a measure to protect a further development of the emergency state.

Though in this description of the preferred embodiment the frame memories 3 an4 are provided in the abnormality detection circuit 30, two frame memories in the second set of frame memories 19 may be further used as the frame memories 3 and 4, with some modification of the circuits according to widely known circuit technique, so that the number of the expensive frame memories can be saved.

Furthermore, the visible light camera system 14, 18 and 20-1 is advantageous in a daytime monitoring, as well as the second infrared camera system 15, 19 and 20-2 is advantageous in a nighttime monitoring.

As an alternative, the abnormality detection circuit 30 may also include the offset adder 11, the binarization circuit 12 and the extractor circuit 13 as described in the second preferred embodiment. Or, the abnormality detection circuit 30 may be also composed simply of a comparator 21, as shown in FIG. 10, without the frame memories 3 and 4, or the histogram operator 10. In this case where the size of the temperature-changed object is not in consideration, the comparator 21 outputs a trigger signal when a temperature signal from the

first infrared camera 1 is higher than a threshold voltage V_0 corresponding to a predetermined temperature level.

Though in the above-described number of the first and second set frame memories 18 and 19 was referred to five each, the number may be increased depending on the requirement. For the first and second set of the frame memories 18 and 19, not only a RAM but also a disk memory may be employed.

The many features and advantages of the invention are-apparent from the detailed specification and thus, it is intended by the appended claims to cover all such features and advantages of the system which fall within the true spirit and scope of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

Claims

1. An emergency watching system, characterized by
an infrared camera (1), having a plurality of picture elements, for monitoring an object scene, each picture element detecting the temperature of corresponding portion of said object scene;
two frame memories (3, 4), each of which alternately stores single frame temperature data of said object scene monitored by said infrared camera; said stored data being renewed with the currently received data of said temperature data;
a differential operator (5) for outputting a difference that is a reduction of the previously stored temperature data from said currently stored temperature data in a corresponding address of each of said frame memories (3, 4);
a histogram operator (10) for counting the quantity of picture elements, belonging to each predetermined temperature segment, and being output from said differential operator (5), said histogram operator (10) outputing a signal to trigger a device (9) for warning of said emergency when the quantity of picture elements belonging to a predetermined temperature range exceeds a predetermined threshold condition.

2. An emergency watching system according to claim 1, further characterized by
an adder circuit (11) for adding a predetermined offset temperature to each temperature of picture elements currently stored in said frame memory (3, 4), said offset temperature being predetermined according to an anticipated temperature difference between a temperature of said object scene without an occurrence of a temperature change to be detected and a temperature of an object having said temperature change to be detected, said added temperature data being input to said differential operator (5′) in place of said currently stored temperature data from said frame memory (3, 4).

3. An emergency watching system according to claim 2, further characterized by
a binarization circuit (12) for binarizing said output of said differential operator (5′) by said offset temperature and other temperatures than said offset temperature, said binarization circuit (11) outputting a logic level signal for said offset temperature as well as a second logic level signal for said other temperatures than said offset temperature; and
an extractor circuit (13) for extracting said temperature data currently stored in said frame memory (3, 4) when said binarization circuit (12) outputs said second logic level signal, said extracted temperature data being input to said histogram operator (10).

4. An emergency watching system according to anyone of claims 1 to 3,
characterized in that
said predetermined temperature range is higher than a predetermined first threshold temperature, and said predetermined threshold condition is a predetermined first threshold quantity of said picture elements.

5. An emergency watching system according to anyone of claims 1 to 3,
characterized in that
said predetermined temperature range is higher than a predetermined first threshold temperature and lower than a second threshold temperature, and said predetermined threshold condition is a predetermined first threshold quantity of said picture elements.

6. An emergency watching system according to anyone of claims 1 to 5,
characterized in that
said histogram operator (10) outputs a signal when a quantity of picture elements belonging to any of said predetermined temperature segments exceeds a predetermined first threshold quantity of said picture elements.

7. An emergency watching system according to anyone of claims 1 to 5,
characterized in that
said histogram operator (10) outputs a signal when a total quantity of picture elements belonging to said predetermined temperature segments and exceeding a predetermined first threshold quantity of said picture elements exceeds a predetermined second threshold quantity.

8. An emergency watching system according to anyone of claims 1 to 7, characterized in that said predetermined temperature range as well as said predetermined threshold conditions of quantity of said picture elements in said histogram operator circuit (10) are replaceable by a software.

9. An emergency watching system according to anyone of claims 1 to 8, characterized in that said infrared camera (111-i, i-1,2 ...n; 211-i) being provided in a plural number; and in that it further comprises:
a plurality of switches (113), each selectively connecting an output of one of said plural infrared cameras (111-i; 211-i) to said memory control circuit (2);
a plurality of specification tables (123), each storing different histogram specifications of an operation of said histogram operator circuit (10′), said histogram specifications including said temperature range and said threshold condition of said picture elements; and
a switching controller (125) for selectively connecting one of said switches to be conductive so as to renew said stored data in said frame memory (3, 4), while selecting a corresponding one of said histogram specifications to input to said histogram operator (10′).

10. A monitoring system characterized by
a first infrared camera (1), having a plurality of picture elements, for monitoring a predetermined object scene (20), each picture element detecting the temperature of a corresponding portion of said object scene;
first and second frame memories (3, 4), each of which alternately stores single frame temperature data of said object scene (20) monitored by said infrared camera (1); said stored data being renewed with said temperature data currently received;
a differential operator (5) for outputting a data that is a reduction of the previously stored temperature data from currently stored temperature information in a same address of each of said first and second frame memories (3, 4);
a histogram operator (10, 10′) for counting the quantity of picture elements belonging to each predetermined temperature segment and being outputting from said differential operator (5), said histogram operator (10, 10′) outputs a trigger signal when the quantity of picture elements belonging to a specific temperature segment exceeds a predetermined threshold quantity, a visible light camera (14) having a plurality of picture elements, for monitoring said object scene (20);
a second infrared camera(15), having picture elements corresponding to picture elements of said visible light camera (14), for monitoring said object scene (20), each picture element detecting the temperature of said object scene (20);
a third memory (18) composed of a plurality of frame memories, each of which circulatorily stores image data of each frame sequentially output from said visible light camera (14), said circulatory storage being discontinued when said trigger signal is output from said histogram operator (10, 10′), whereby said image data stored in any one of said frame memories of said third memory (18) is ready to be output; and
a fourth memory (19) composed of a plurality of frame memories, each of which circulatorily stores temperature data of each frame sequentially output from said second infrared camera (15), said circulatory storage being discontinued when said trigger signal is output from said histogram operator (10, 10′), whereby said temperature data sorted in any one of said frame memories of said fourth memory (19) is ready to be output.

11. An emergency watching system according to claim 10, characterized in that at least one frame data stored in said third or fourth memory (18, 19) prior to said trigger signal as well as at least one frame data stored in said third or fourth memory (18, 19) on or after said trigger signal are output to be displayed (20-1; 20-2).

12. An emergency watching system, characterized by
a first infrared camera (1), having a plurality of picture elements, for monitoring an object scene (20), each picture element detecting the temperature of a corresponding portion of said object scene (20);
an abnormality detection circuit (30) for detecting a temperature change belonging to a predetermined temperature range out of temperature data received from said first infrared camera (1), so as to output a signal;
a visible light camera (14), having a plurality of picture elements, for monitoring said object scene (20);
a second infrared camera (15), having picture elements corresponding to picture elements of said visible light camera (14), for monitoring said object scene (20), each picture element detecting the temperature of said object scene (20);
a first set (18) of a plurality of frame memories, for circulatorily storing current frame data received from said visible light camera (14), said circulatory storage of said current data being suspended at the n-th frame after receiving said signal;
a second set (19) of a plurality of frame memories, for circulatorily storing current frame data received from said second infrared camera (15), said circulatory storage being suspended at the n-th frame stored after receiving said signal; and

display means (20-1, 20-2) for displaying a scene out of said data stored in one of said first or second set (18, 19) of frame memories.

13. An emergency watching system according to claim 12, characterized in that at least one frame data stored in said first or second set (18, 19) of frame memory prior to said signal as well as at least one frame data stored in said first or second set (18, 19) of frame memory on or after said signal are output to be displayed.

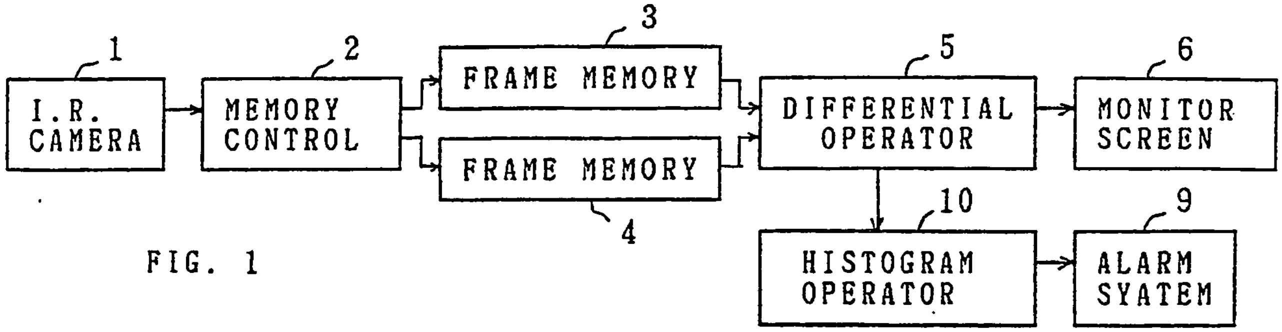


FIG. 1

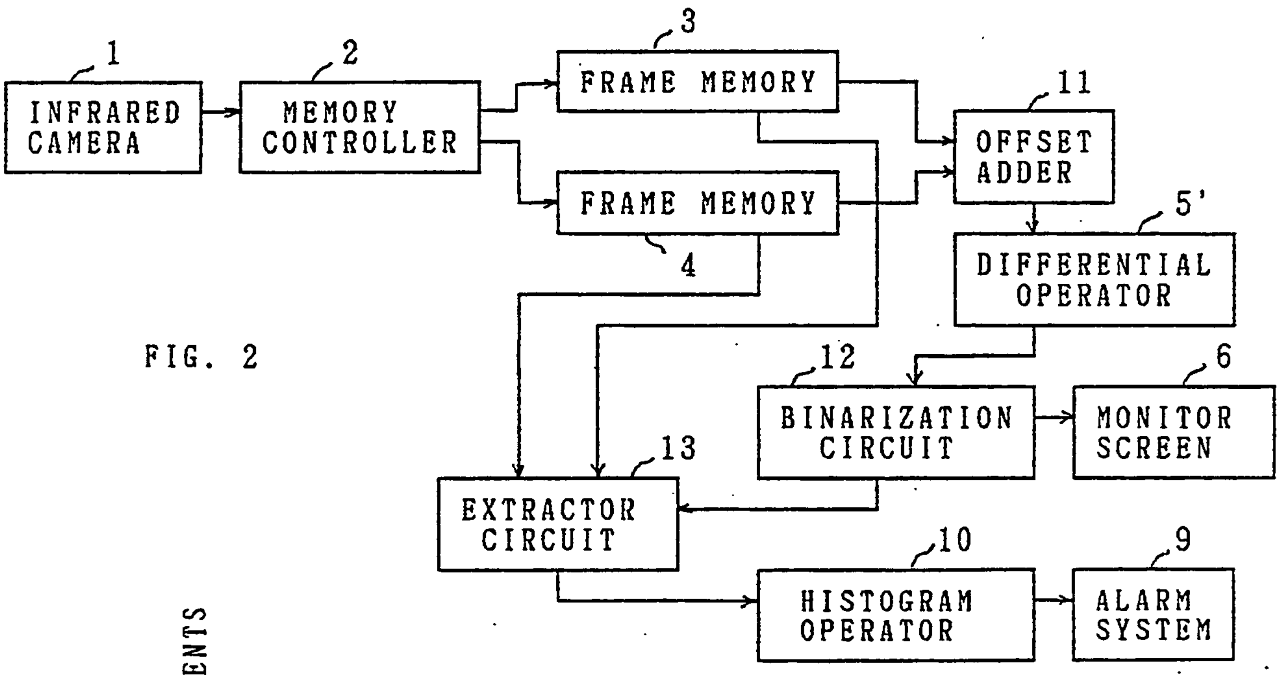


FIG. 2

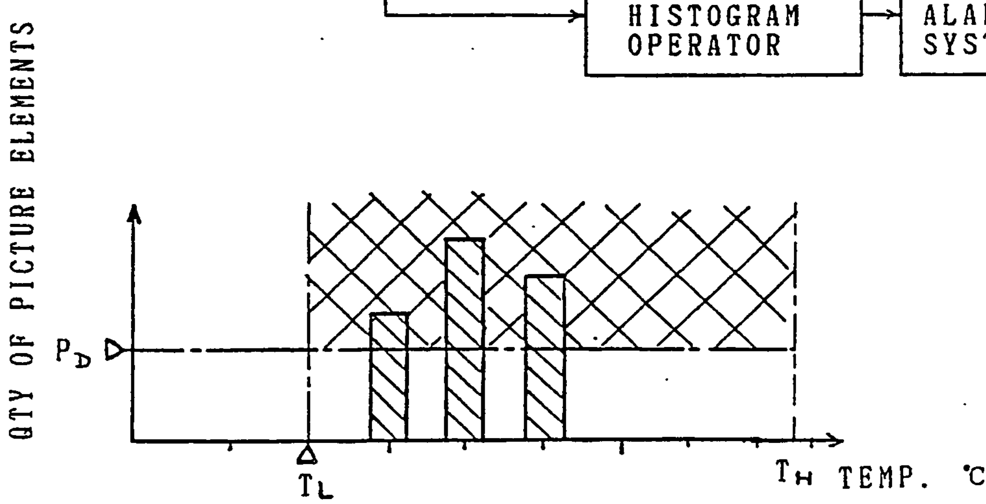
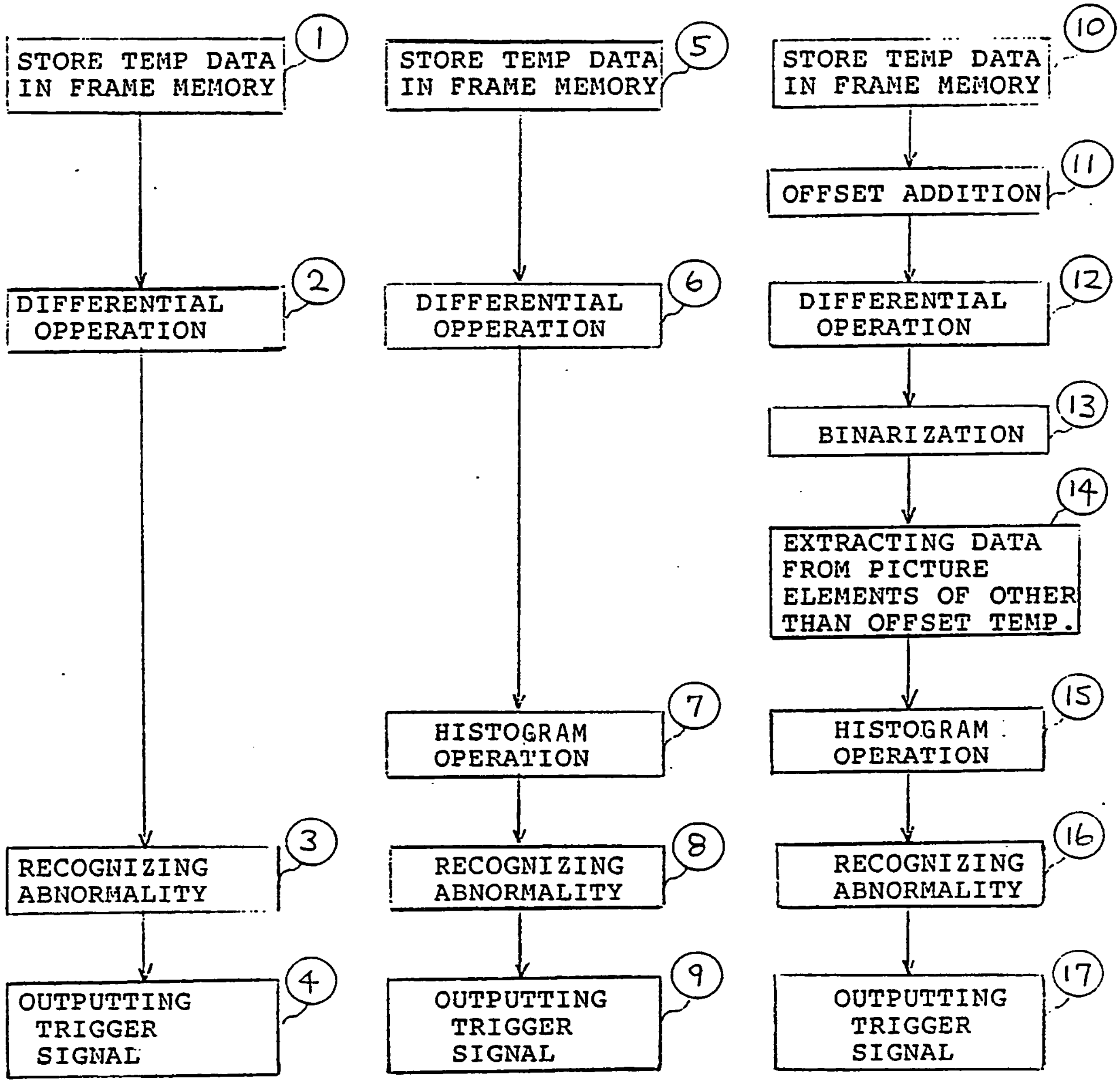


FIG. 4



PRIOR ART

FIG. 3(a)

FIRST EMBODIMENT

FIG. 3(b)

SECOND EMBODIMENT

FIG. 3(c)

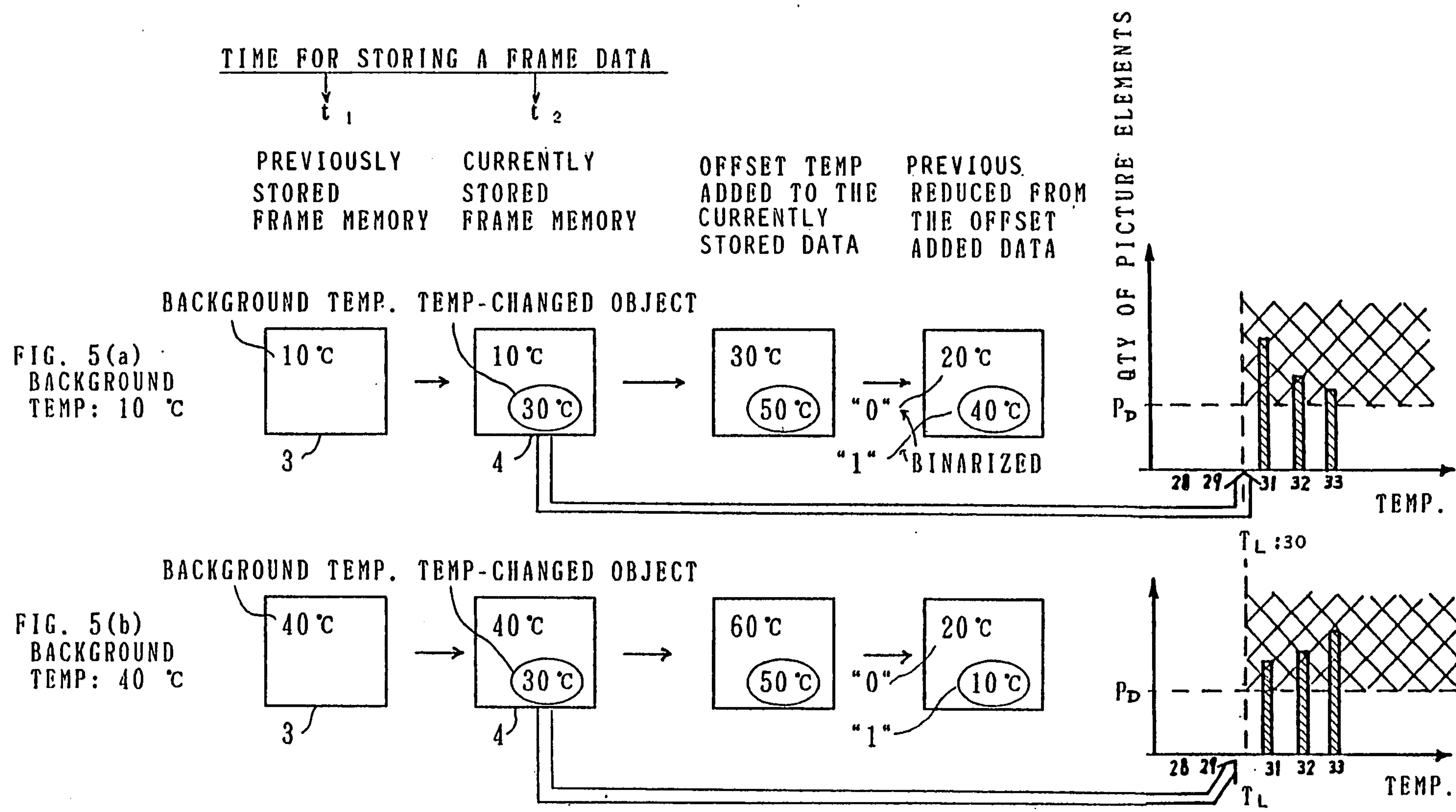
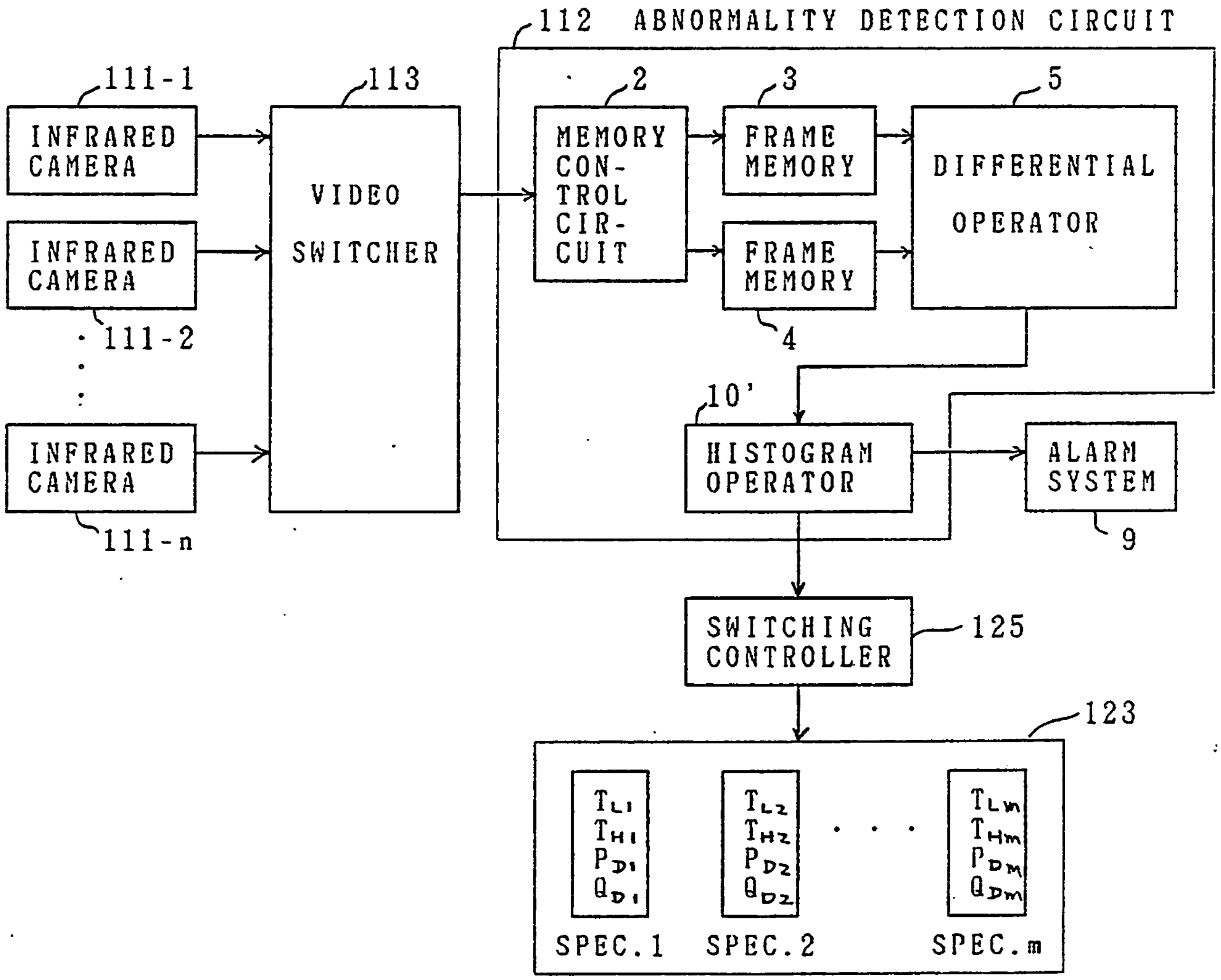

TIME FOR STORING A FRAME DATA
t_1
t_2
PREVIOUSLY STORED FRAME MEMORY
CURRENTLY STORED FRAME MEMORY
OFFSET TEMP ADDED TO THE CURRENTLY STORED DATA
PREVIOUS REDUCED FROM THE OFFSET ADDED DATA
FIG. 5(a) BACKGROUND TEMP: 10 ℃
BACKGROUND TEMP.
TEMP-CHANGED OBJECT
10℃
3
10℃
30℃
4
30℃
50℃
"0"
"1"
20℃
40℃
BINARIZED
QTY OF PICTURE ELEMENTS
P_D
28 29 31 32 33
TEMP. ℃
T_L:30
FIG. 5(b) BACKGROUND TEMP: 40 ℃
BACKGROUND TEMP.
TEMP-CHANGED OBJECT
40℃
3
40℃
30℃
4
60℃
50℃
"0"
"1"
20℃
10℃
P_D
28 29 31 32 33
TEMP. ℃
T_L
30

FIG. 5



112 ABNORMALITY DETECTION CIRCUIT
111-1
INFRARED CAMERA
INFRARED CAMERA
111-2
INFRARED CAMERA
111-n
113
VIDEO SWITCHER
2
MEMORY CON-TROL CIR-CUIT
3
FRAME MEMORY
FRAME MEMORY
4
5
DIFFERENTIAL OPERATOR
10'
HISTOGRAM OPERATOR
ALARM SYSTEM
9
SWITCHING CONTROLLER
125
123
T_{L1} T_{H1} P_{D1} Q_{D1}
SPEC.1
T_{L2} T_{H2} P_{D2} Q_{D2}
SPEC.2
T_{Lm} T_{Hm} P_{Dm} Q_{Dm}
SPEC.m

FIG. 6

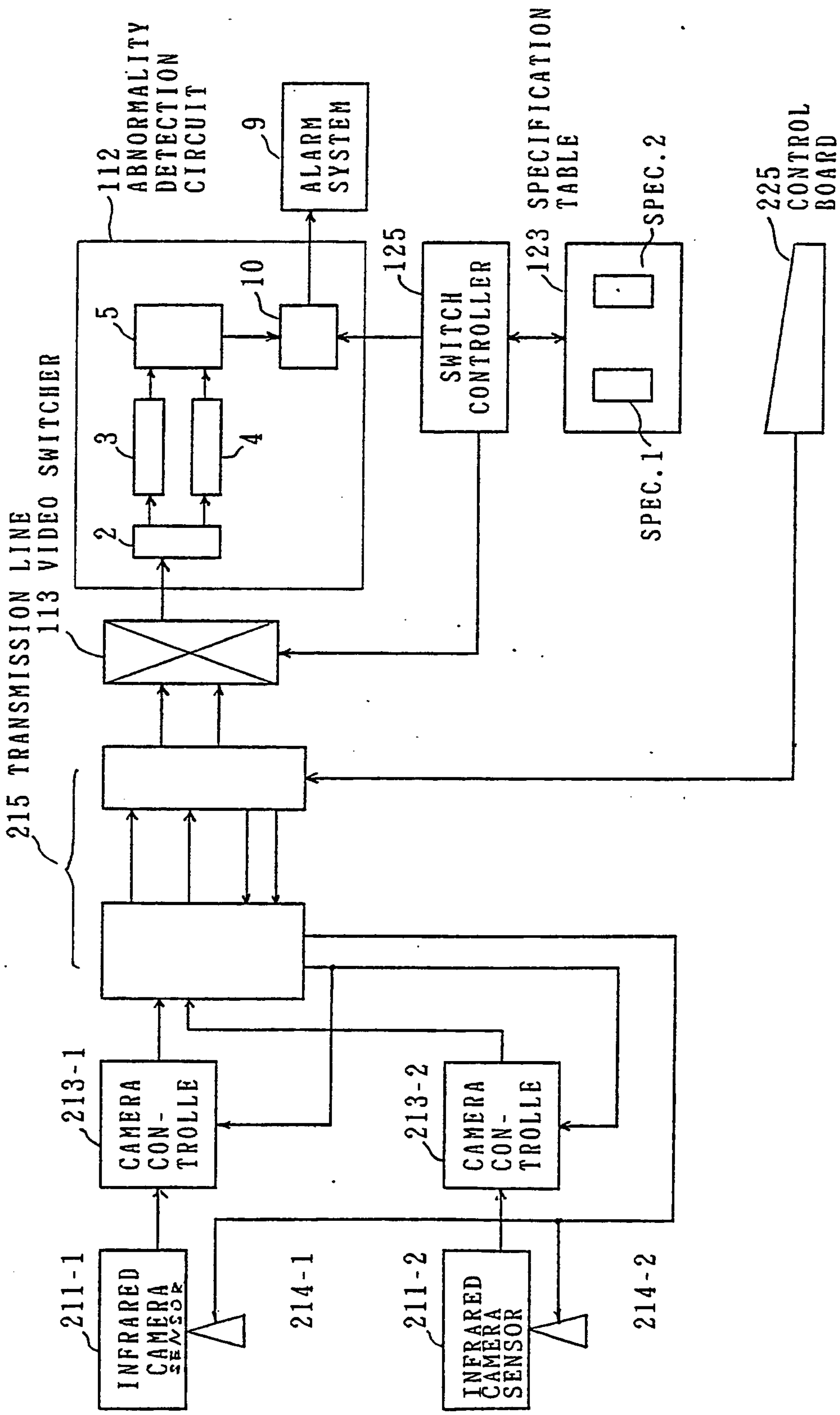

112 ABNORMALITY DETECTION CIRCUIT
9
ALARM SYSTEM
125
SWITCH CONTROLLER
123 SPECIFICATION TABLE
SPEC.1
SPEC.2
225 CONTROL BOARD
215 TRANSMISSION LINE
113 VIDEO SWITCHER
2
3
4
5
10
213-1
CAMERA CON-TROLLE
213-2
CAMERA CON-TROLLE
211-1
INFRARED CAMERA SENSOR
211-2
INFRARED CAMERA SENSOR
214-1
214-2

FIG. 7

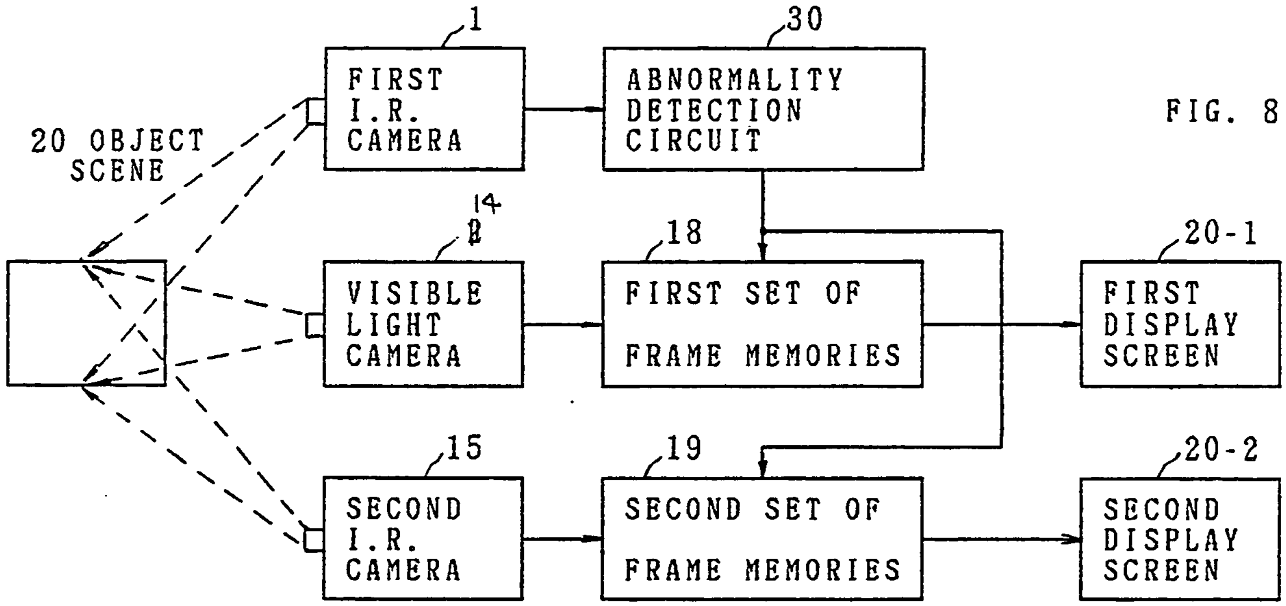


FIG. 8

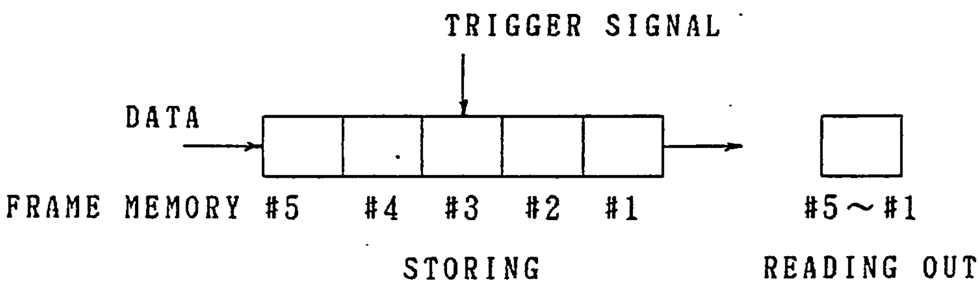


FIG. 9

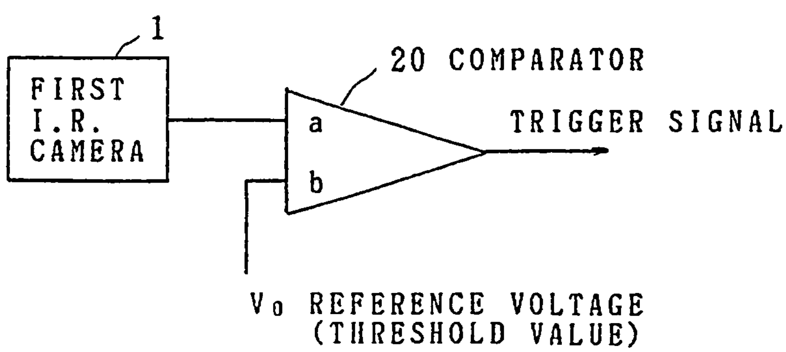


FIG. 10

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(54) **An emergency watching system using an infrared image processing.**

(57) Temperature data of each picture element output from an infrared camera (1) looking at a scene to be watched is compared with the same data of the previous frame. Temperature data changed from the previous frame is input to a histogram operator (10) having a region defined by temperature and quantity of the picture element. When a quantity of the picture elements in the defined region exceeds a threshold level, it is recognized that a certain object having considerable temperature change and size is detected to output a signal to trigger an alarm system (9), or to sustain circulating frame memories (3, 4) which have recorded the previous scenes so that the scenes of visible light as well as the temperature patterns, frames prior and on/or after the signal output, can be reproduced as visual images on a display screen. It is preferable to add an offset temperature to the current frame temperature data before the above mentioned comparing operation, so that the circuit becomes simple owing to an always positive comparison result.

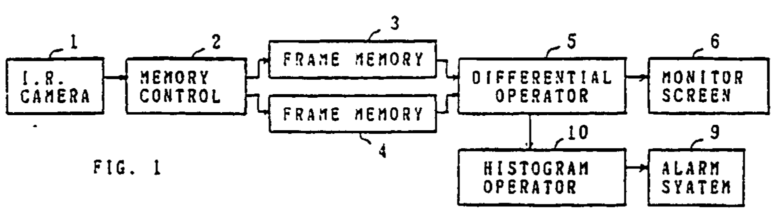

FIG. 1

EP 0 318 039 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 11 9697

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	EP-A-0 213 867 (RANK PULLIN CONTROLS LTD) * Figures 1-6; page 3, lines 5-23,45-57 *	1,4,6-13	G 08 B 13/18
D,Y	PATENT ABSTRACTS OF JAPAN, vol. 11, no. 320 (E-5550), 17th October 1987; & JP-A-62 111 588 (FUJITSU LTD) * Whole document *	1,4,6-13	
Y	FR-A-2 517 916 (THOMSON-CSF) * Page 4, line 4 - page 5, line 3 *	1,4,6-13	
A	EP-A-0 107 042 (CERBERUS AG)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

G 08 B 13

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14-09-1990	CRECHET P.G.M.

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